

Lake Pepin & South Metro Mississippi TMDL

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TMDL Study Domain

Metro Mississippi – Lake Pepin

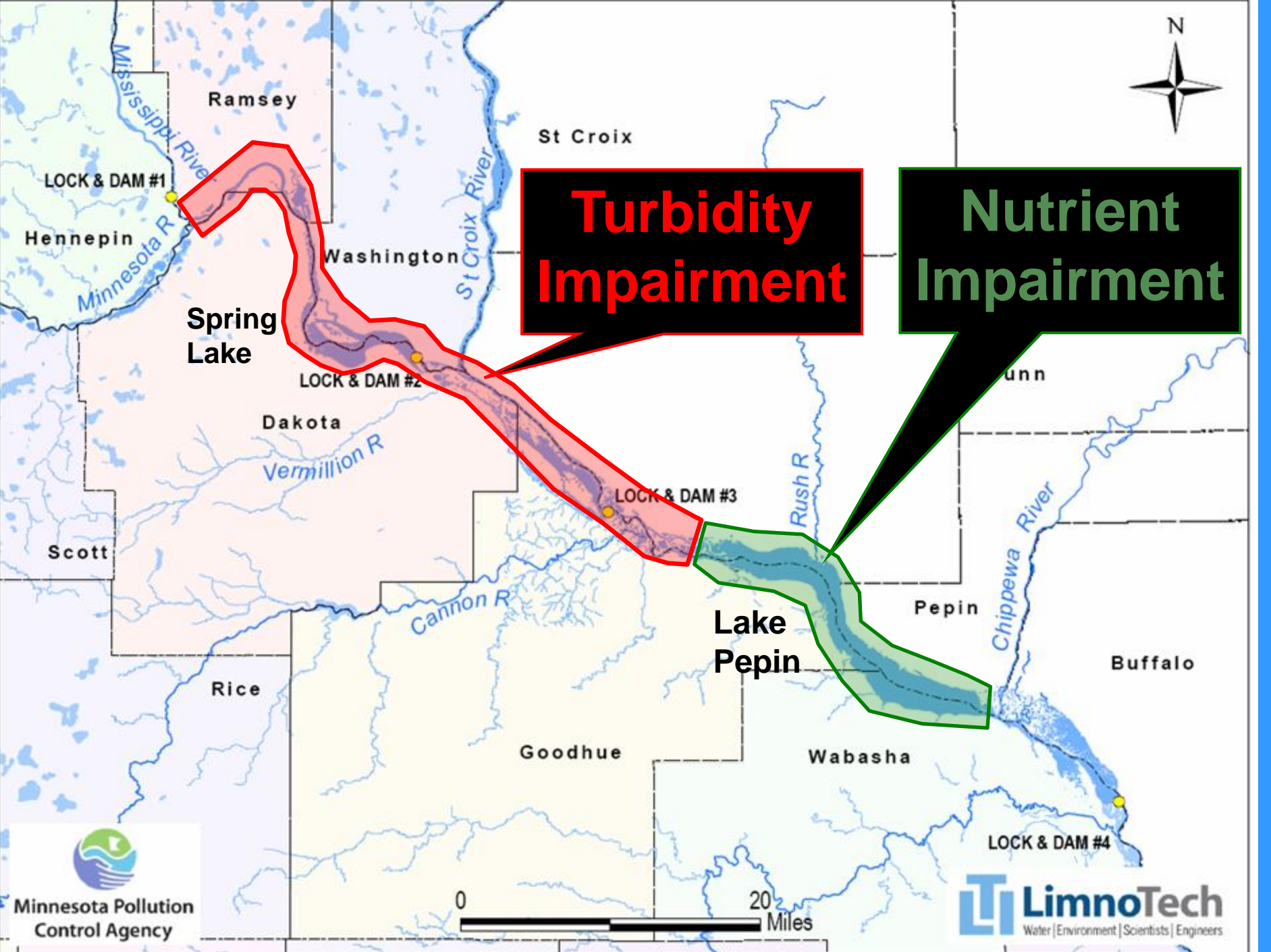


Photo Credit: Angie Hong, Washington County SWCD



**Turbidity
Impairment**

**Nutrient
Impairment**





Minnesota

Mississippi Headwaters

North Dakota

St. Croix

Wisconsin

South Dakota

Minnesota

Vermillion

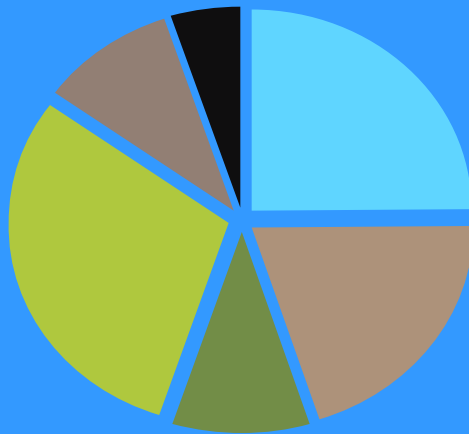
Cannon

Iowa

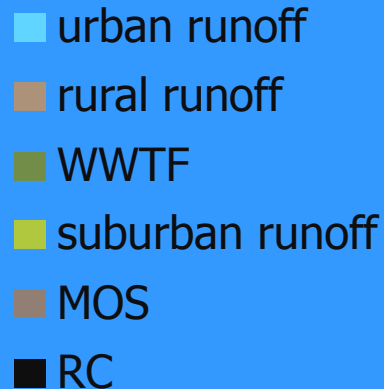


Total Maximum Daily Load Pollutant Load Allocations

Current Allocation



Future Allocation



Mississippi/Pepin Goals

From.....To



Science: TMDL Goals

Site-Specific Standards



- **Eutrophication Targets**

- 32 ug/L Chl a
- 100 ug/L TP
- 0.8 meters Secchi transparency

TSS & Vegetation Target

- 32 mg/L TSS
- 21% frequency SAV-EMAP methods

MISSISSIPPI MAKEOVER

A Plan for
Restoration, Just
Around the Bend



Ecosystem Indicators & Metrics



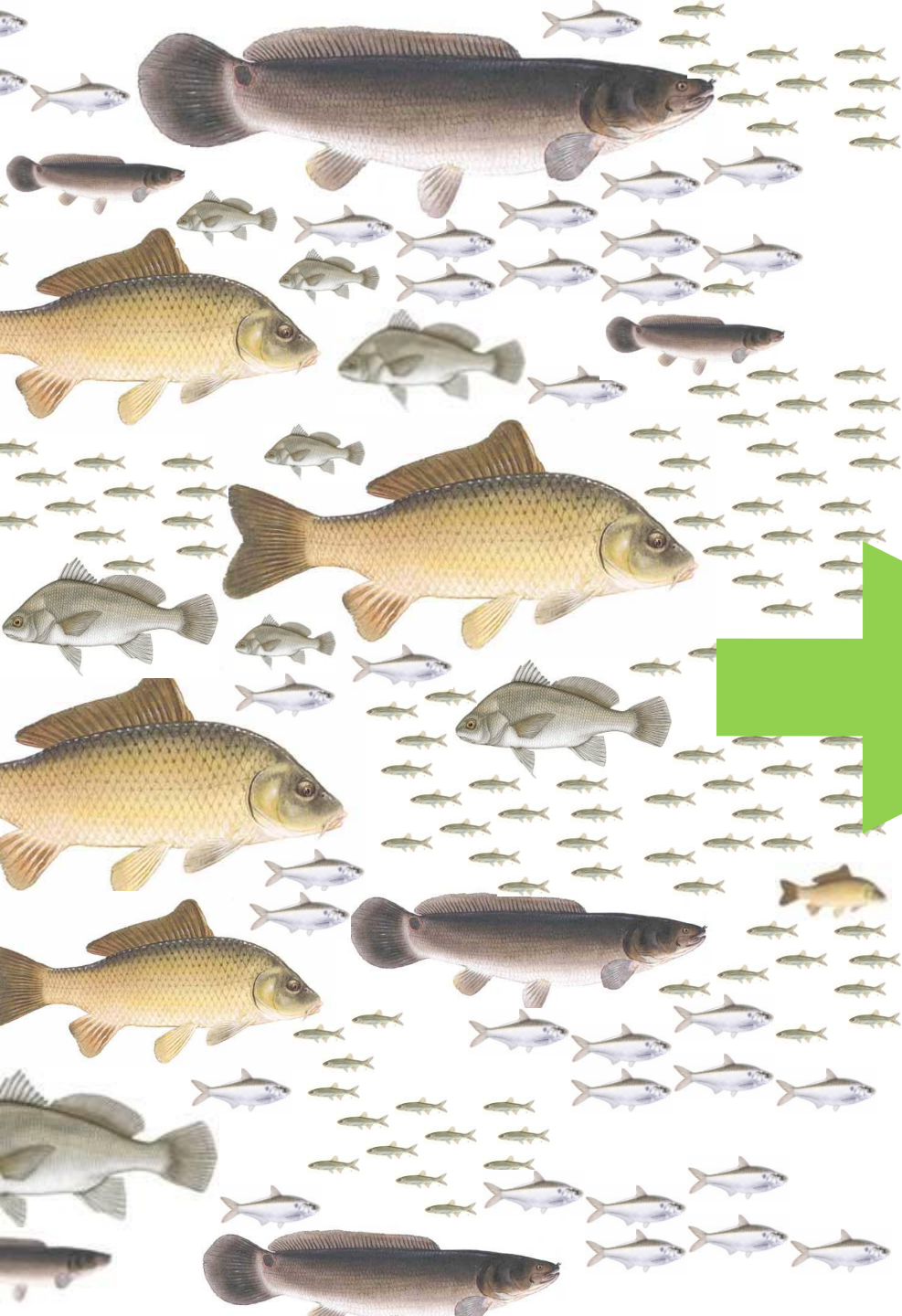
TMDL Endpoints

- 32 ug/L Chl a
- 100 ug/L TP
- 0.8 meters Secchi transparency
- 32 mg/L TSS
- 21% frequency SAV with EMAP methods

Indicators & Metrics for MMakeover

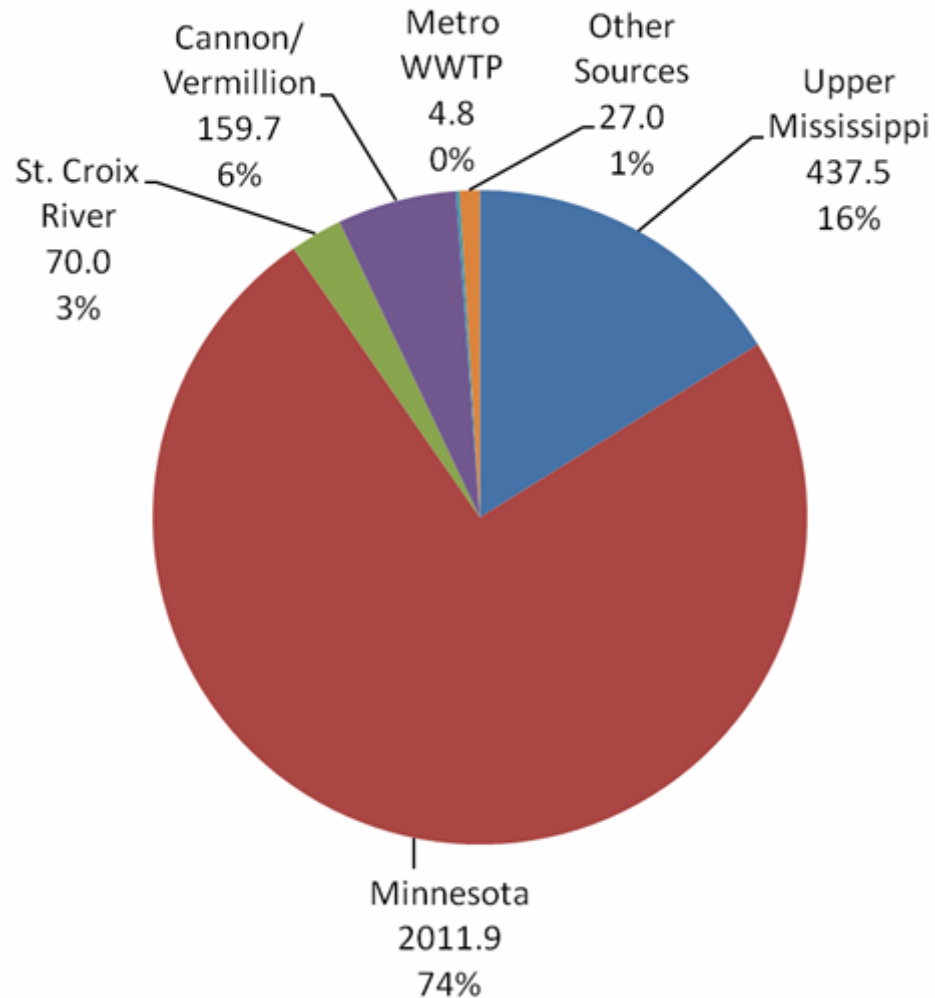
- Water Clarity-Aquatic Vegetation
- Sedimentation
- Invertebrates
- Fish
- Aquatic Habitat Quality Index
- Waterfowl

TMDL and Mississippi Makeover Indicators	Natural background	Existing	8-year interim target	15-year target (meet standards)
Water clarity <ul style="list-style-type: none"> - TSS (mg/l) – summer average 1976-2008, L&Dam #2 and #3 - Secchi (cm) – May–Sept average at L & Dam #3 - Secchi (cm) – Lake Pepin average 		45 38.5 68		32 46.8 80
Aquatic vegetation <ul style="list-style-type: none"> - frequency of occurrence (%) – EMAP sampling, SAV - species richness (maximum # species) 		9 9		21 11
Sedimentation <ul style="list-style-type: none"> - rate (Lake Pepin life span) - load (metric tons/year) 	4,000 80,000	370 865,600		635 502,000
Mississippi Makeover Indicators				
Invertebrates (mussels) <ul style="list-style-type: none"> - catch/unit effort (% sites with ≤ 1/min) - species richness (# species) - Mucket mussel (% of population) 	41 8	33 28 0		20 1
Fish <ul style="list-style-type: none"> - catch per unit effort (individual species) - size structure (individual species) 				

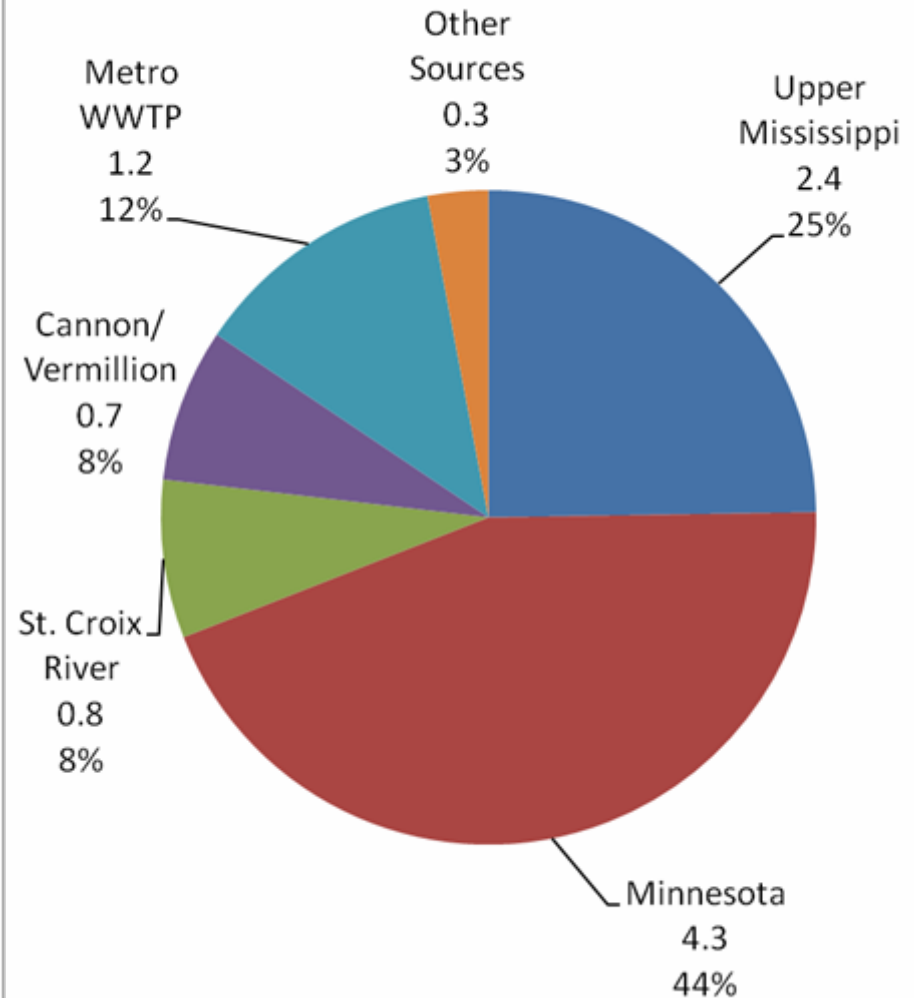


Relative Contributions: Historical Tributary and Permitted WWTP Loads

TSS (MT/d) - 1985 to 2006

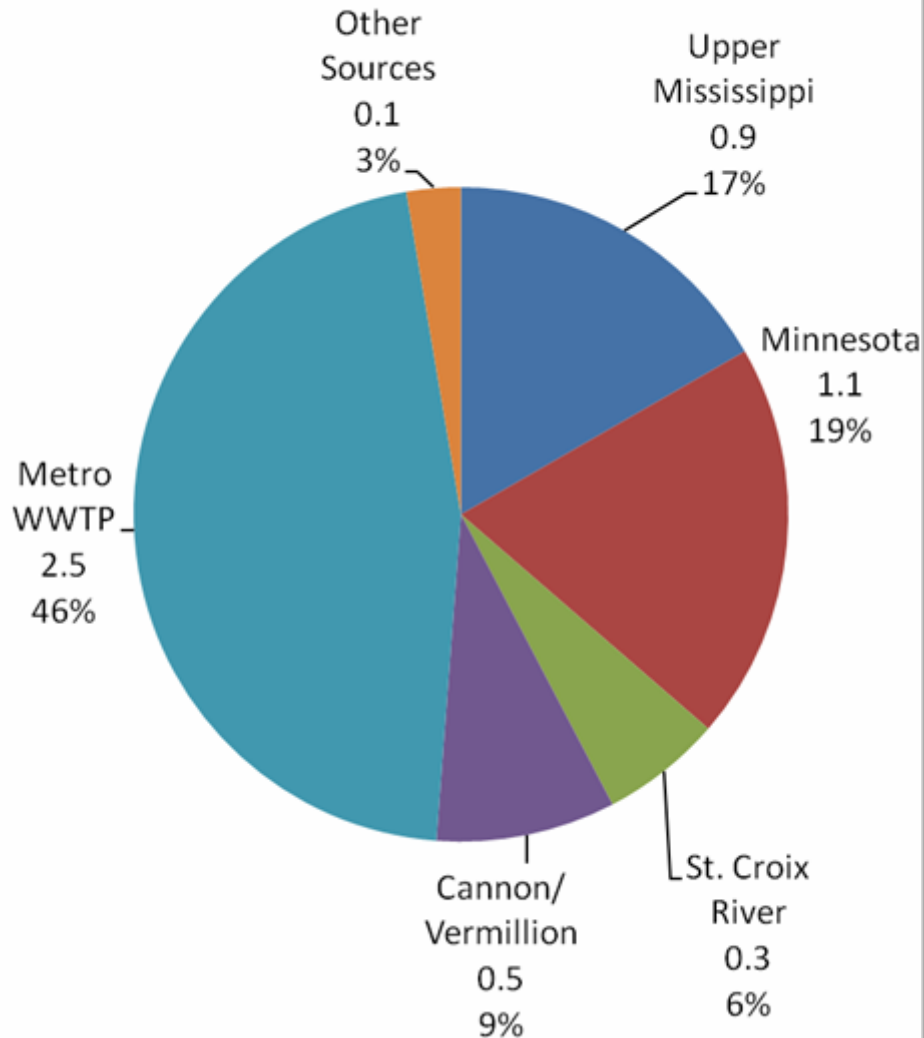


Phosphorus (MT/d) - 1985 to 2006

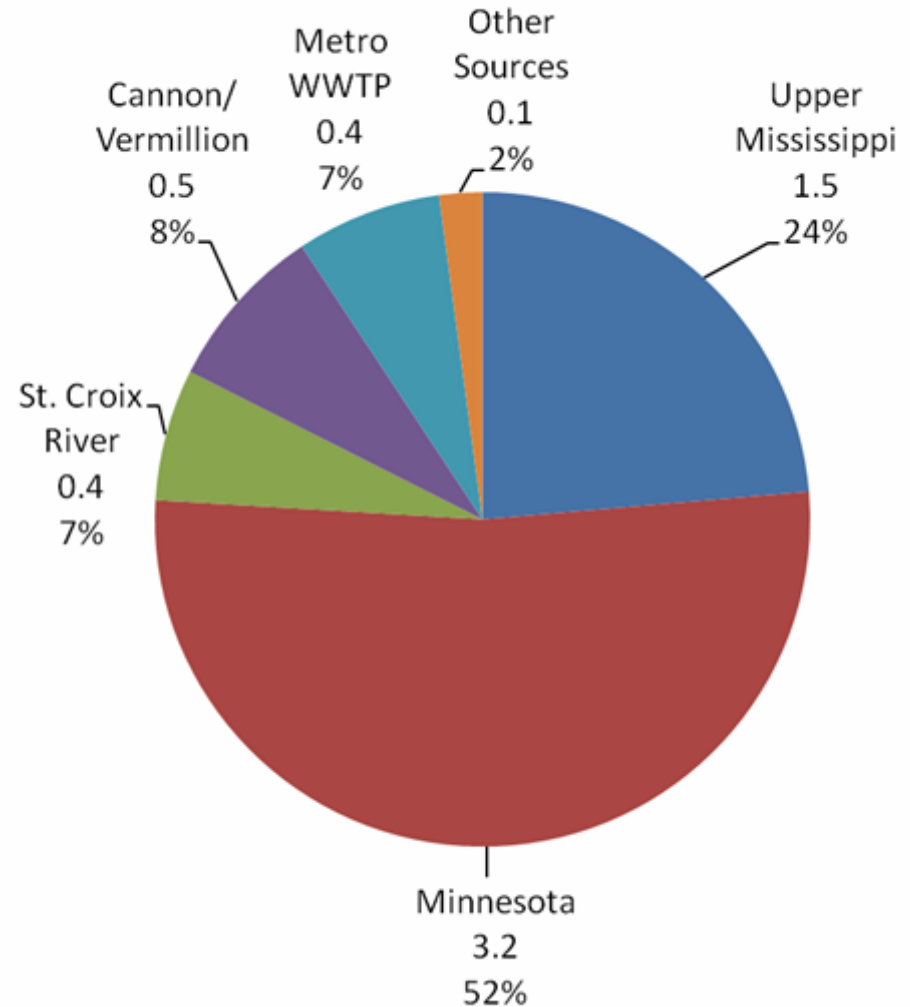


Shift in Historical TP Loads

TP (MT/d) - 1988

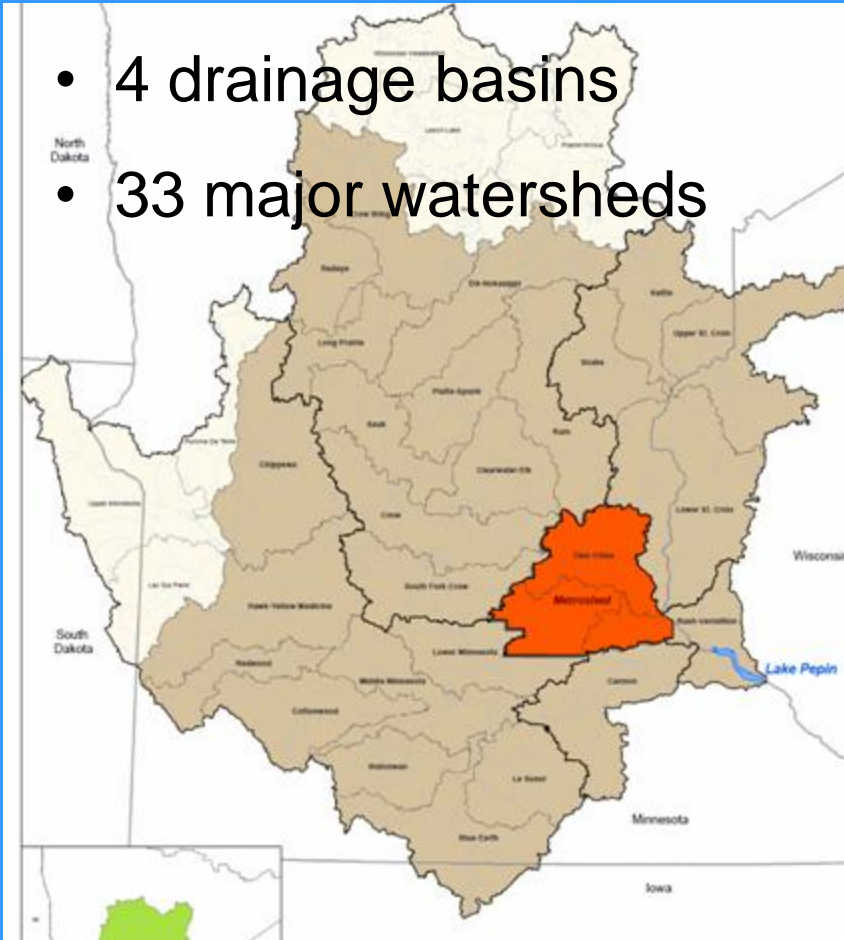


TP (MT/d) - 2006

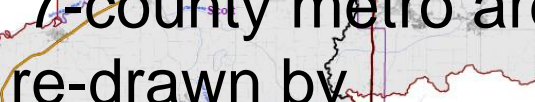


Hydrologic Scale Pepin~Basins~Majors

- 4 drainage basins
- 33 major watersheds

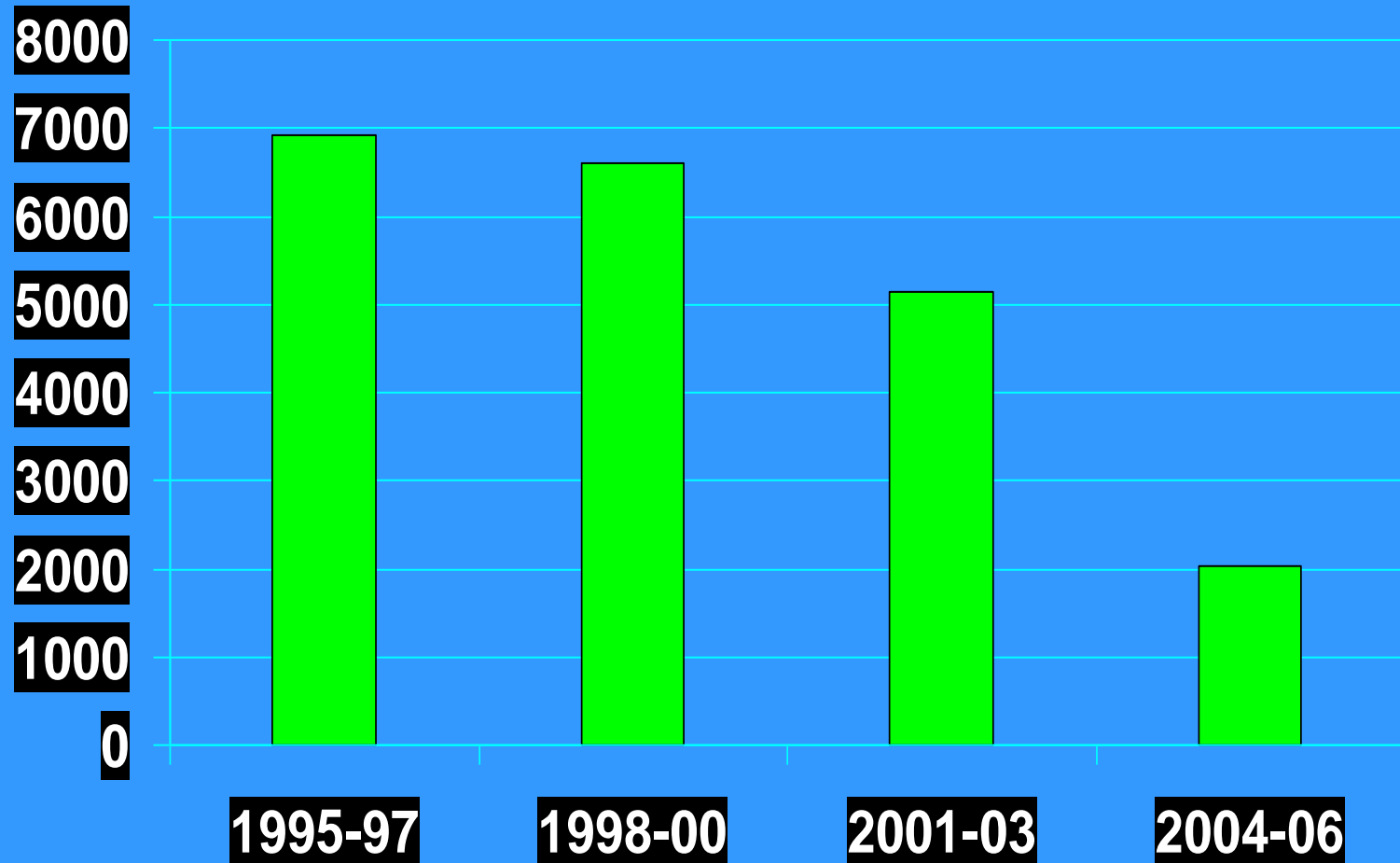


- “Metroshed”

- 
- 7-county metro area
re-drawn by
watershed
boundaries
- The map shows the 7-county metro area with watershed boundaries. The text '7-county metro area' is at the top, 're-drawn by' is in the middle, 'watershed' is below it, and 'boundaries' is at the bottom. The map includes labels for Minnesota, Dakota, and South Dakota, and shows various rivers and roads.

Annual Average TP Load (lb/day)

WWTP Effluent, Twin Cities Metro Area

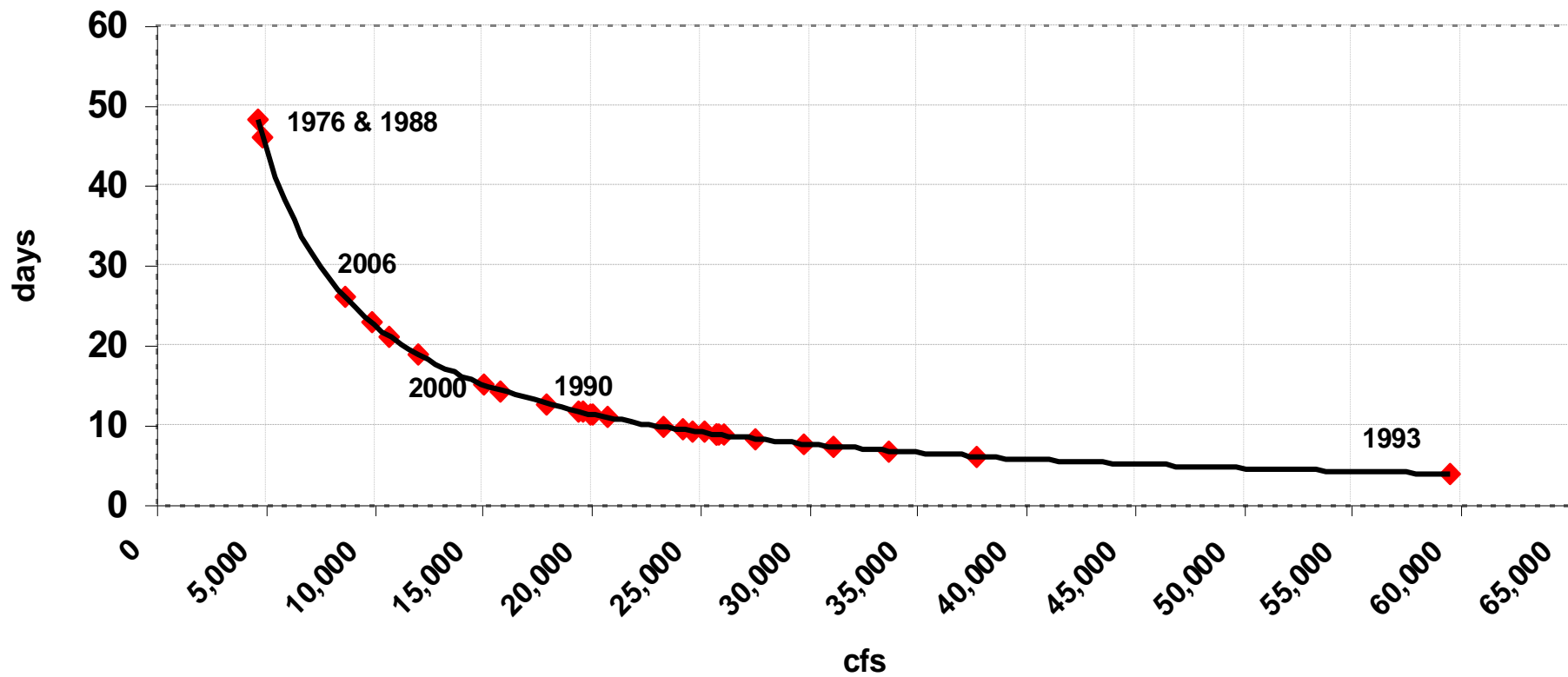


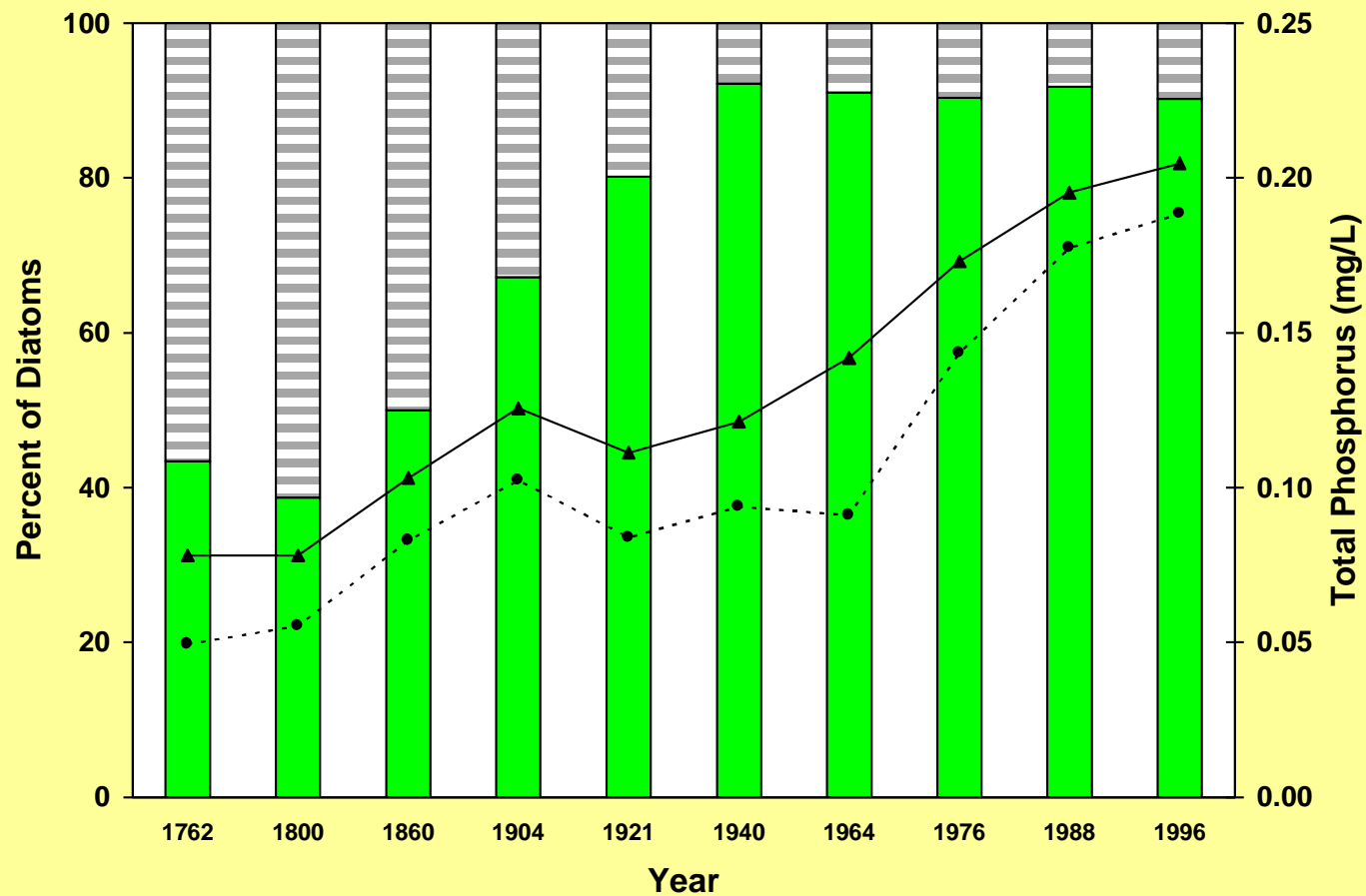
Factors Affecting Eutrophication

Site-Specific Standard

- Residence time of Pepin (days) vs. glacial lakes (years). *Flow is critical*
- Lake Pepin is a low-productivity lake vs. glacial lakes.
- Chlorophyll a not a direct indicator of nuisance algae abundance in Pepin.
 - *Dominated by diatoms vs. blue-greens*

Lake Pepin residence time.
Estimated based on summer-mean flow at Prescott

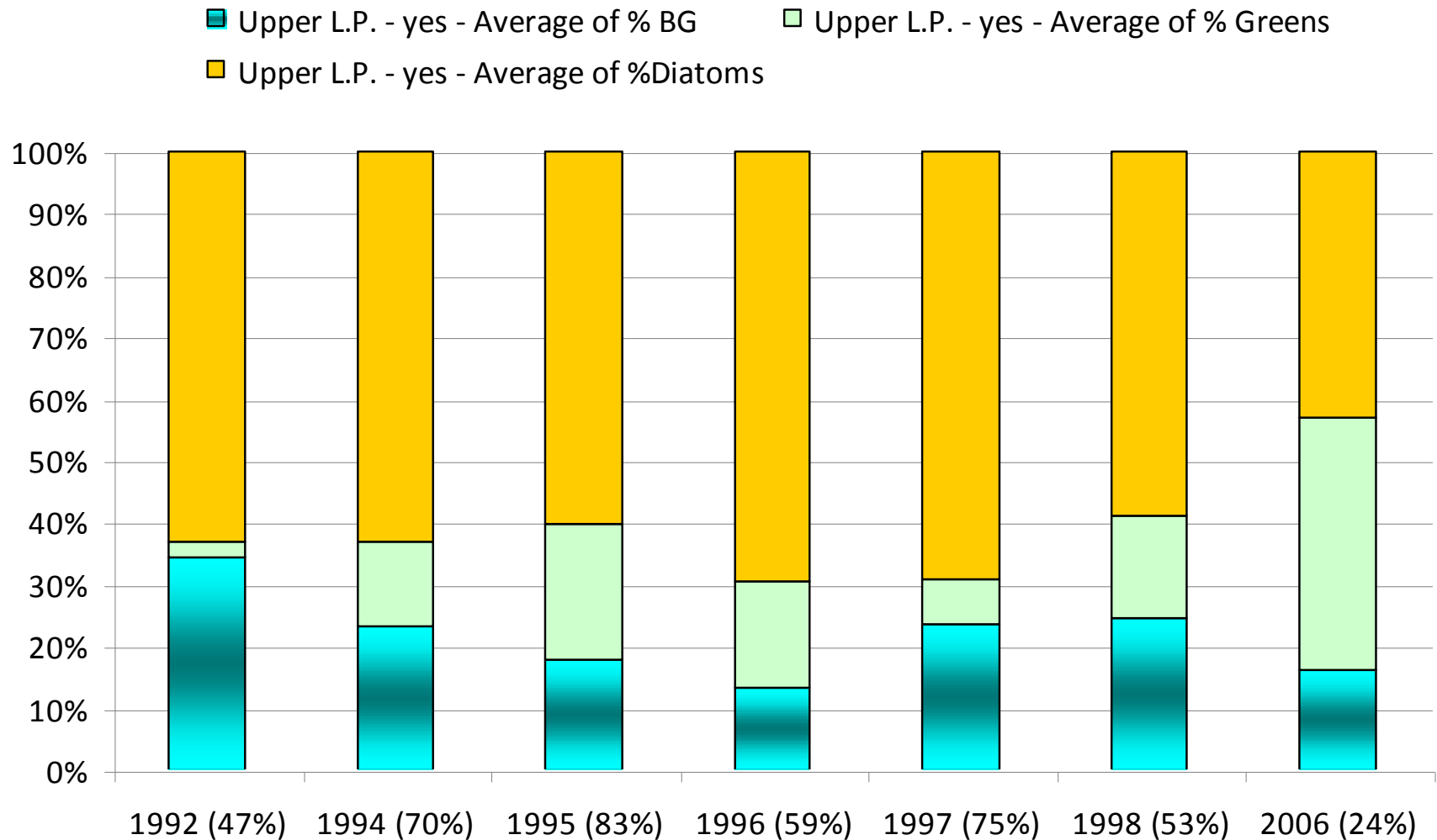




Planktonic Diatoms Benthic Diatoms —▲— TP Estimate #1 ..●... TP Estimate #2

Algal composition available for model development

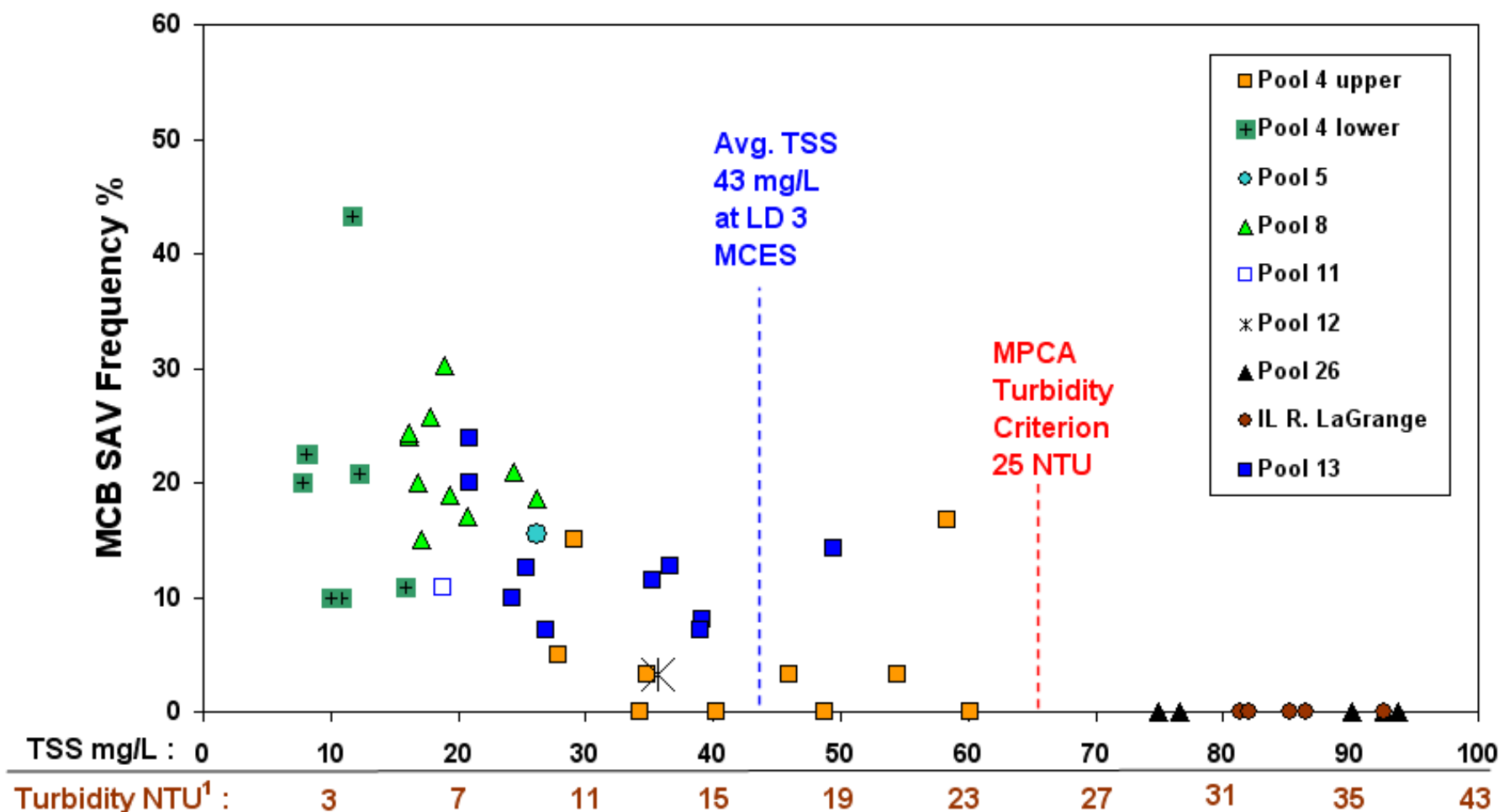
- Lake users respond to BG blooms;
- Blue-greens low % of algal community in most summers



Factors Affecting Site-Specific TSS Standard for Mississippi

- Need to support aquatic life
- Inadequacies of turbidity standard
 - Multiple meters used
 - Turbidity standard silent on critical period, compliance monitoring, etc.
- Importance of Submersed Aquatic Vegetation in Mississippi River ecology
- Availability of data linking TSS to SAV with historical and spatial reference conditions

Avg. Main Channel Border SAV Frequency vs Avg. Summer TSS **LTRMP SRS & Multi Agency WQ Data 1998-2007**

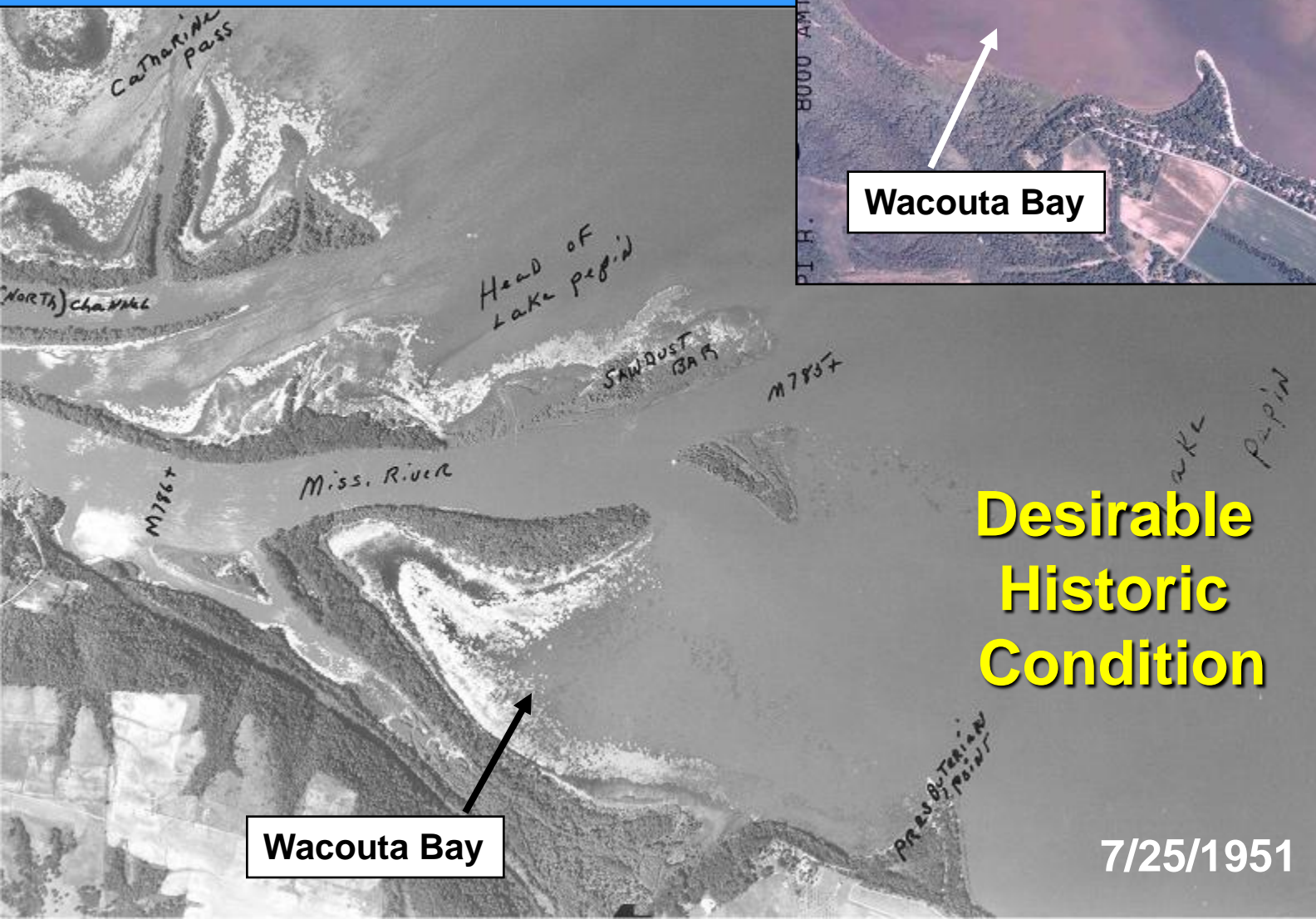


¹ NTU estimate = (TSS-1.9)/2.49 MCES data for LD 3

8/11/2000

Upper Lake Pepin

1951 vs 2000



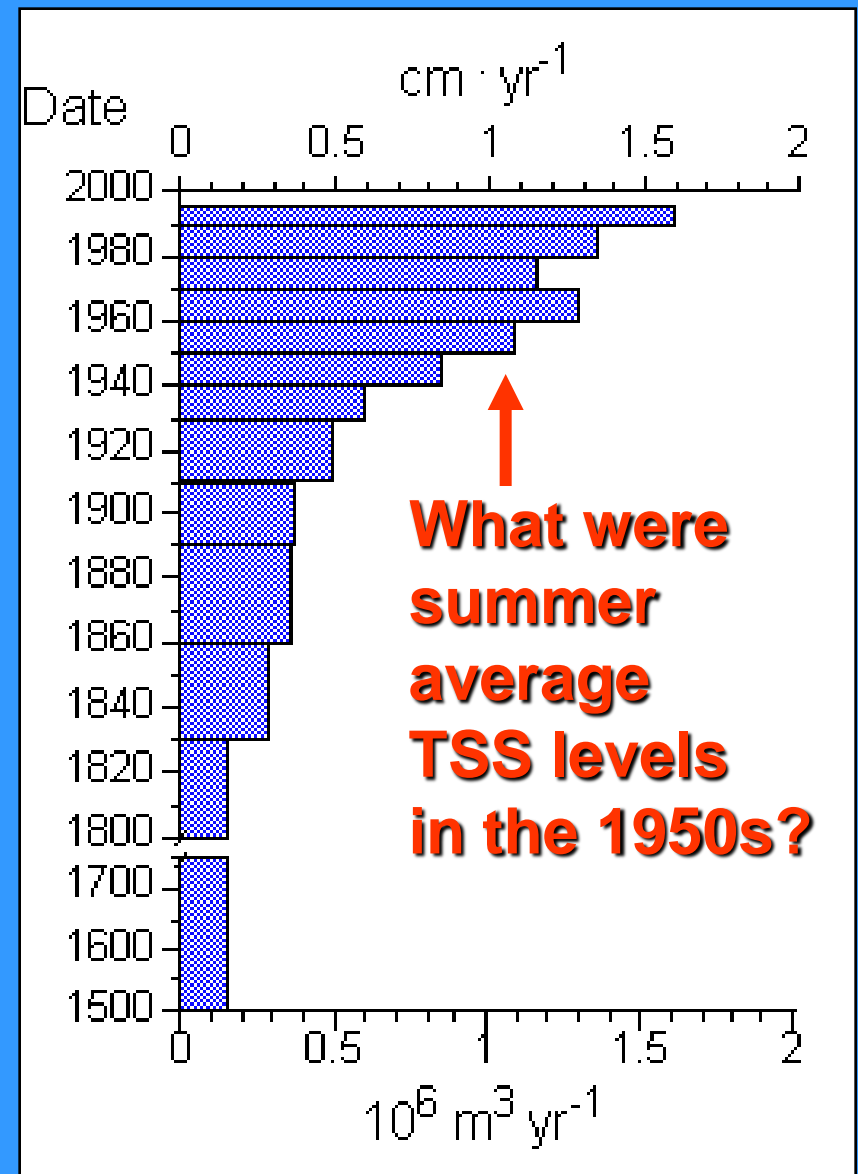
7/25/1951

Lake Pepin Sedimentation Rates Engstrom et al. 2000

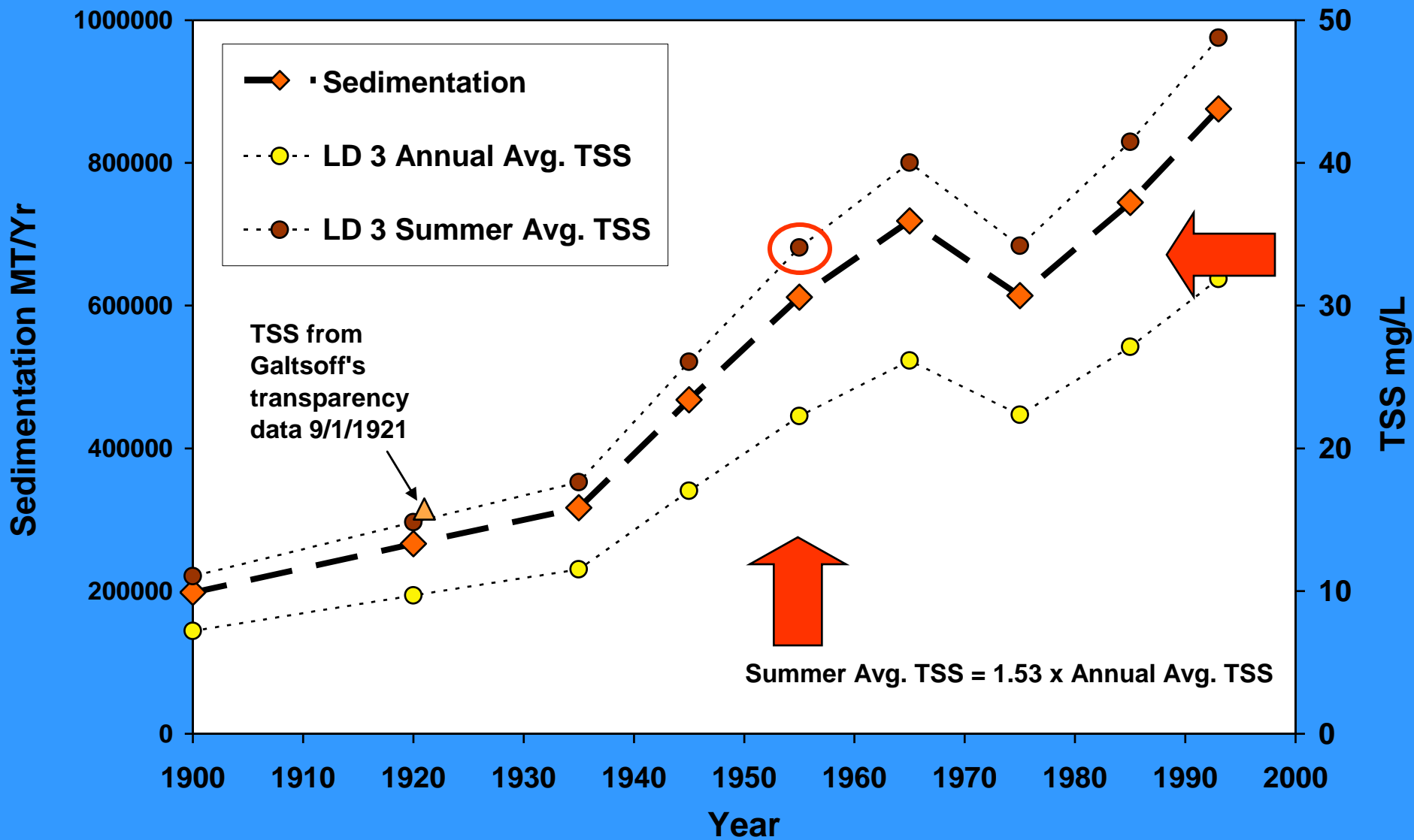
Sedimentation-Derived Estimates of TSS

Ratio:
$$\frac{\text{Sedimentation during period}}{\text{Average TSS during period at LD 3}}$$

Apply ratio "down core"

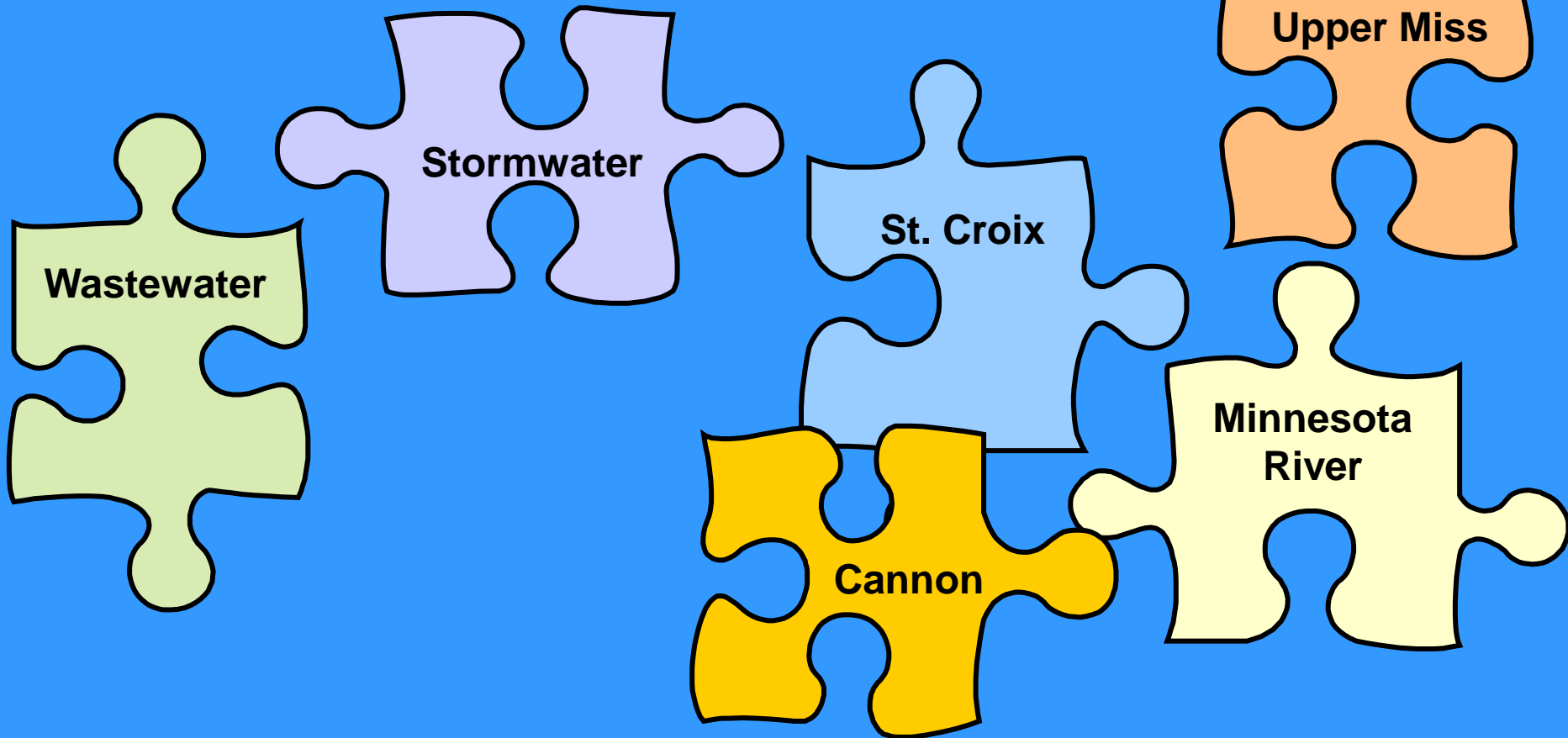


Lake Pepin Sedimentation (Engstrom et al. 2000) & Estimated TSS at LD 3



Solving the TMDL Puzzle: Assigning Phosphorus Allocations

- Wastewater Allocations
- Stormwater Allocations
- Tributary Basin Allocations



Scenarios to Meet Standards

Do Different Loads Allow South Metro Mississippi, Lake Pepin to Meet Standards Even Under Low-Flow Conditions?

Modeling Predictions to 2006 Conditions

Scenario in Model	Metrosched Wastewater Point Sources Total Phosphoru s	Reductions in Total Phosphorus and Total Suspended Solids		South Metro Mississip pi	Lake Pepin	
		Minnesota River Basin**	Upper Mississippi River Basin**	TSS* Standard: 32	Total P Standard: 100	Chl-a Standard: 32
		M Tons/Year	%	mg/L	µg/L	µg/L
2: No change	Current permit	0	0	32.7	163	36.6
19: Natural background	0	90	90	5.3	22	11
3: First step	Current permit***	20	20	28.4	133	36.5
8: Extreme non- point reduction	Current permit***	80	50	15.7	86	35.0
10: First step with point source freeze	Near current actual	20	20	28.4	111	33.1
17: Meets both standards	Near current actual	50	20	20.7	89	31.3

Notes: * TSS standard is relatively easy to meet in a dry year, reductions in scenario 17 are required to meet the standard in wetter years

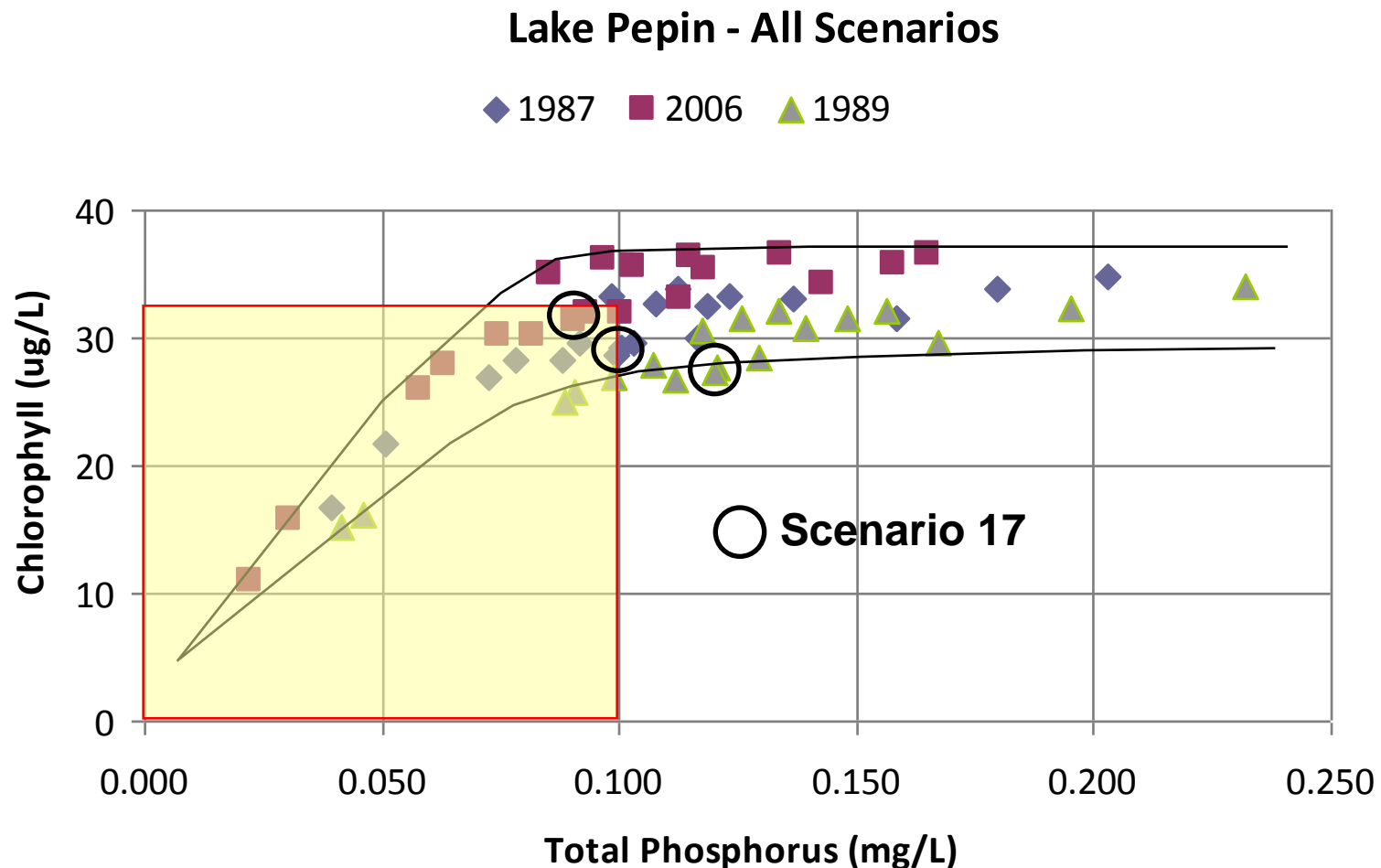
** St. Croix reductions are fixed at 20% and Cannon River reductions are fixed at 50%, this reflects the reductions called for in local TMDLs.

***Represents 70% reduction from what permit allowed prior to 2005

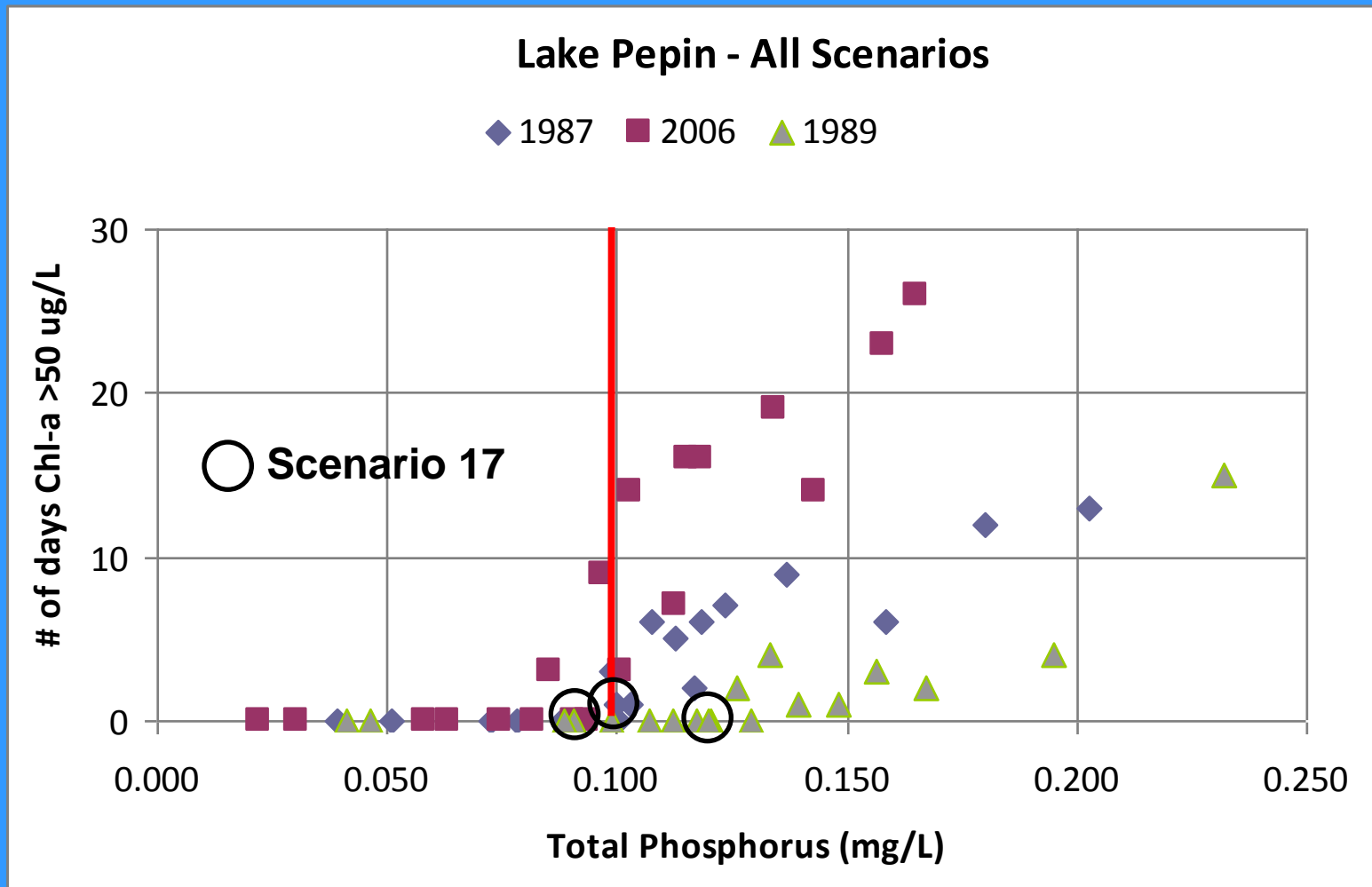
One Scenario Could Meet Both Standards

- Scenario 17
 - 50% reductions in TP and TSS loads from Minnesota River and Cannon River basins.
 - 20% reductions in TP and TSS loads from St. Croix and Upper Miss basins.
 - Metroshed reductions
 - Short term
 - Hold wastewater TP constant
 - 25 to 50% reduction in Stormwater runoff (urban v. urbanizing)
 - Long term (2030)
 - 70% reduction in permitted TP load from wastewater

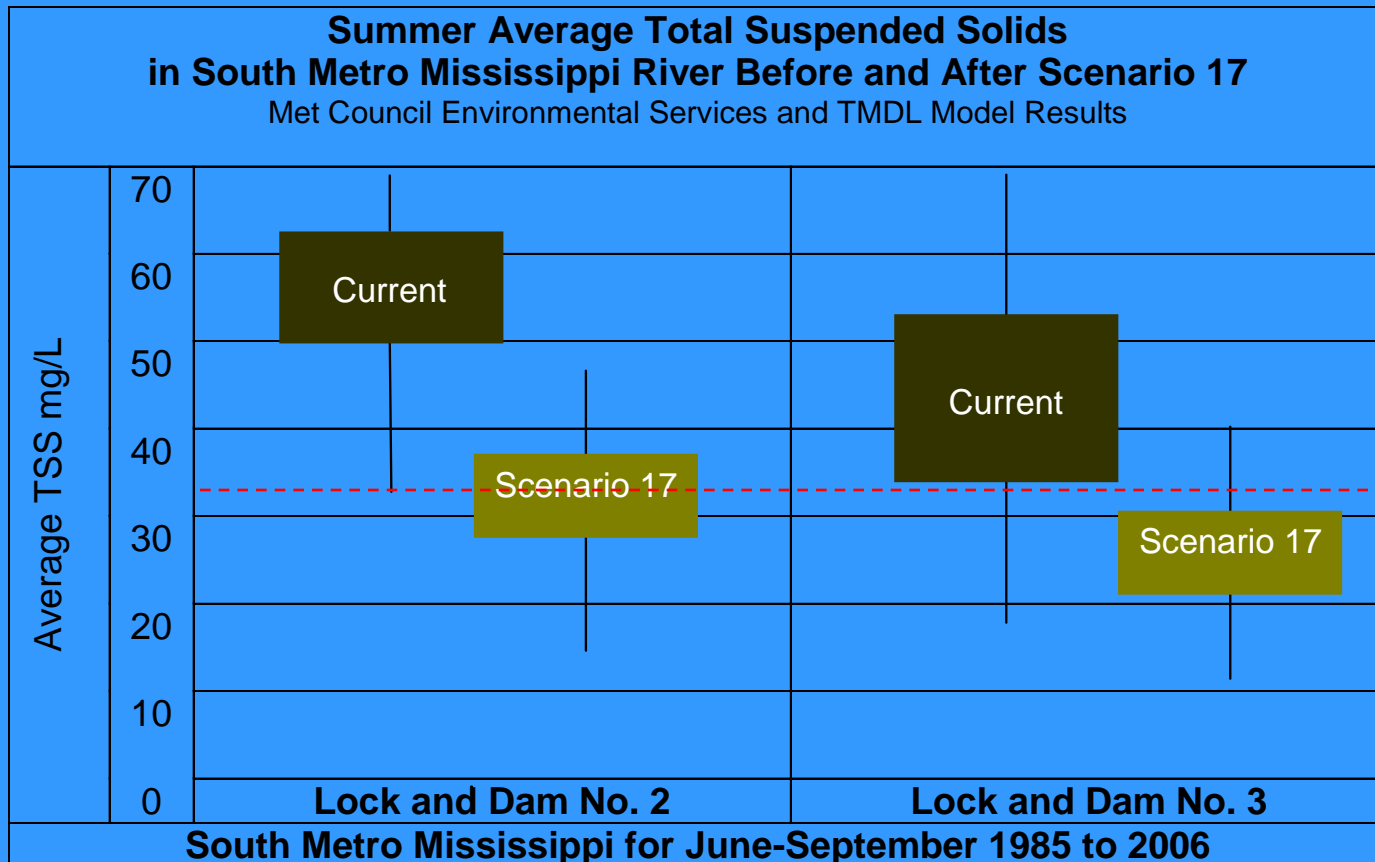
Effect of TP Reductions on Chl-a, Lake Pepin Average, Low-Flow Conditions, June - Sept.



Effect of TP Reductions on Chl-a, # of days > 50 ug/L, Low-Flow Conditions, June - Sept.

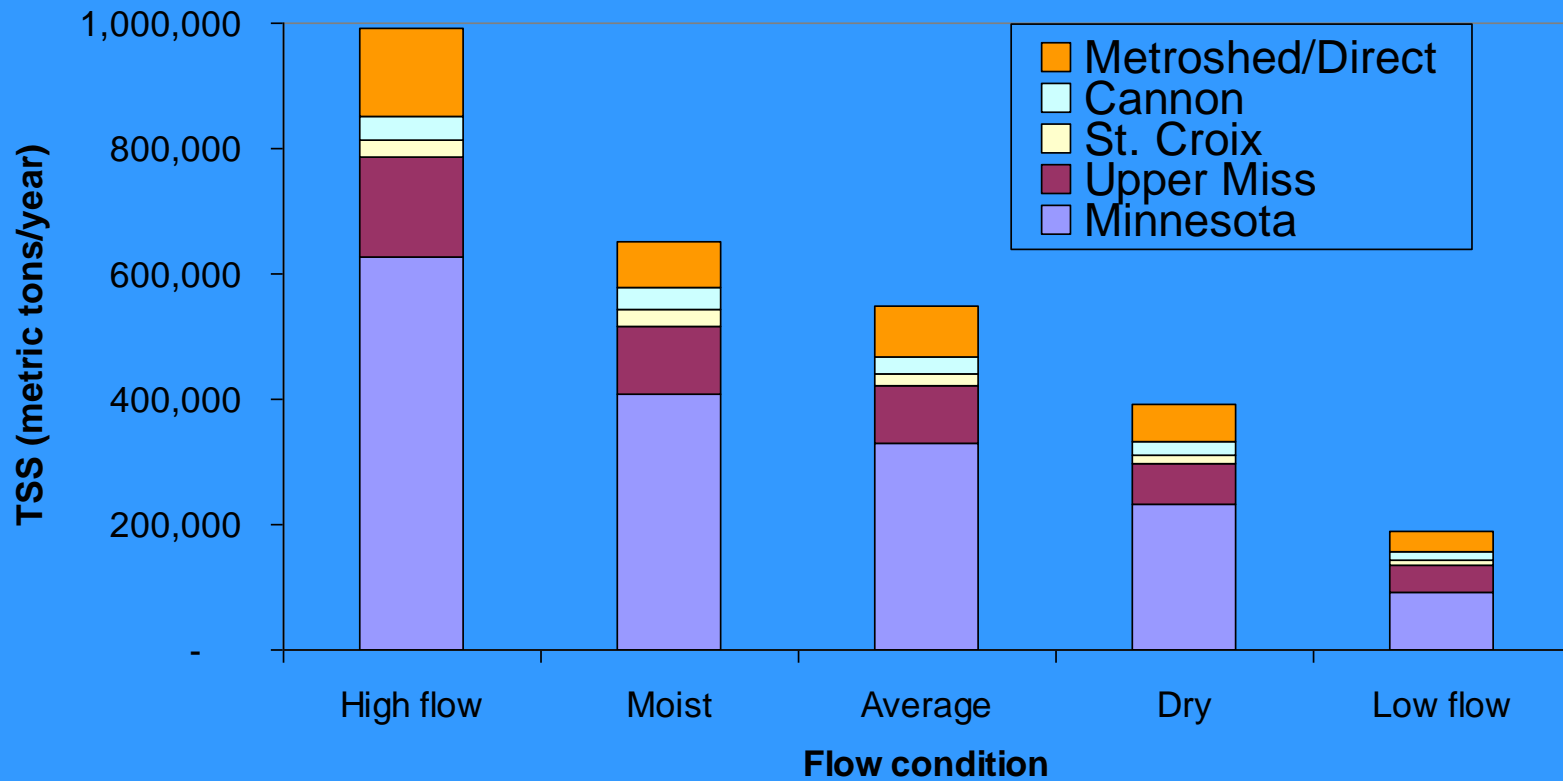


Scenario 17 Could Meet TSS Standard for South Metro Mississippi



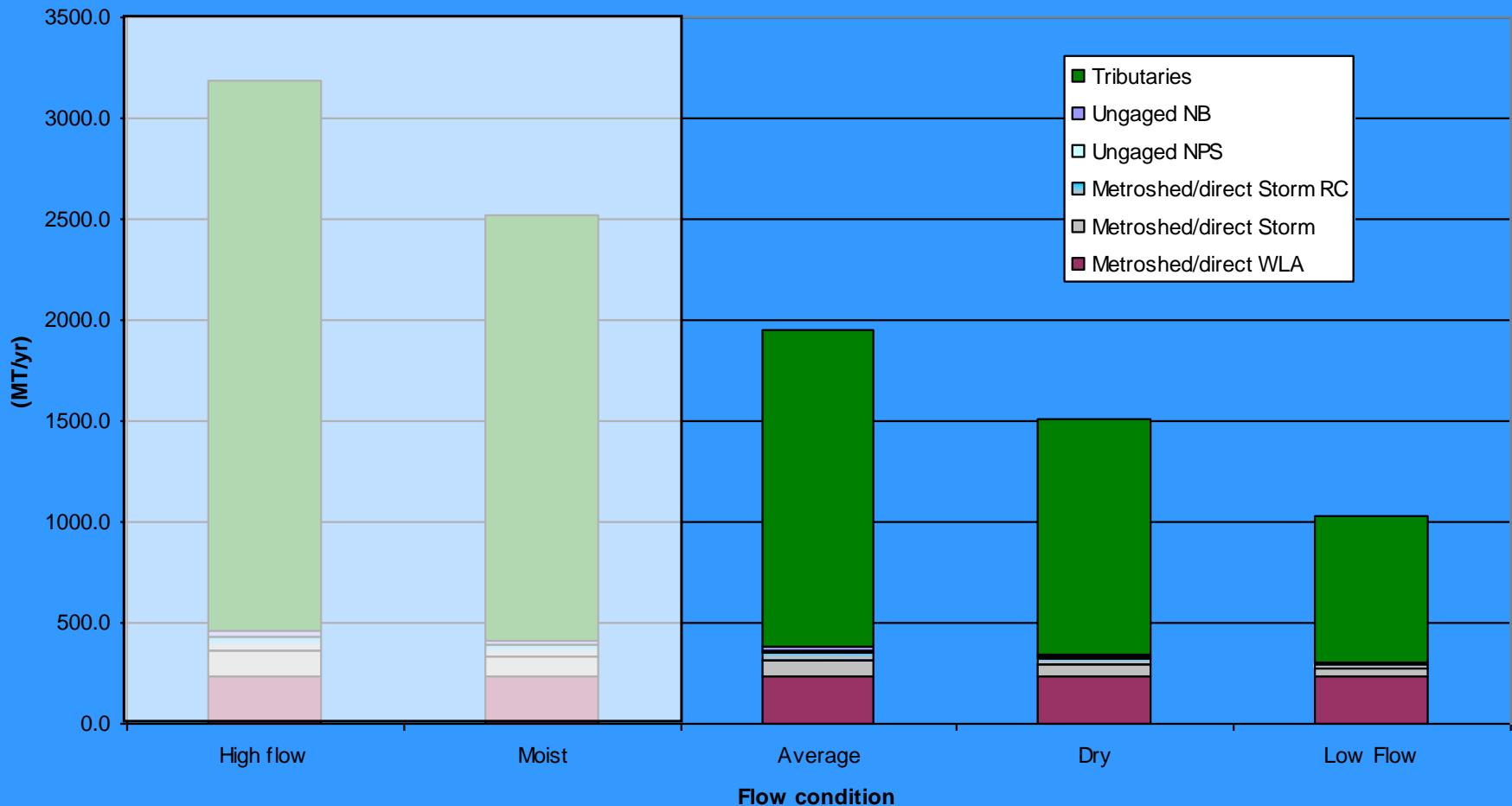
TSS Draft Allocations

Scenario 17



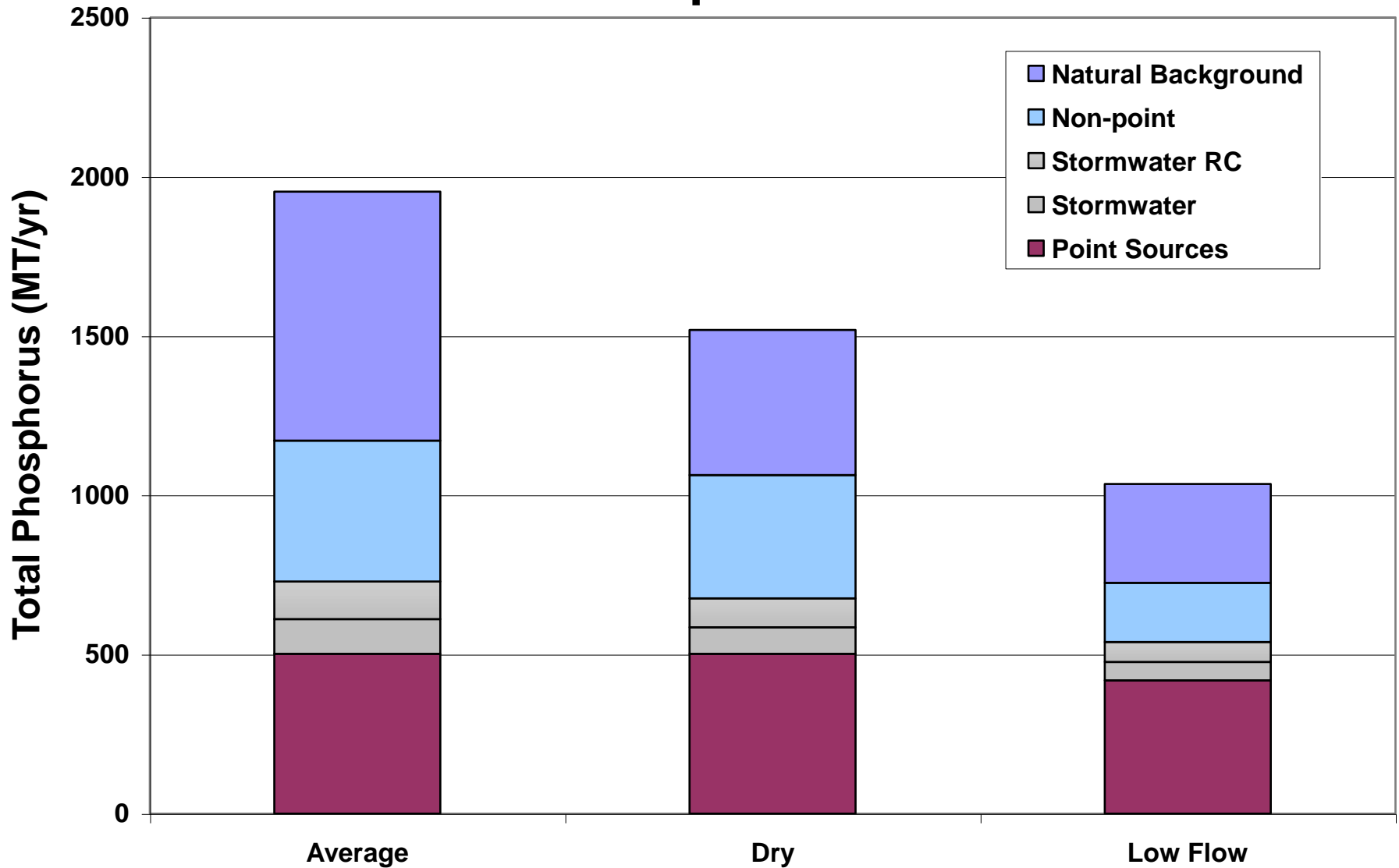
Metroshed and Tributary TP Load Allocations

Lake Pepin total phosphorus allocations. Note that flushing rate in the lake limits algal response during moist to high flow conditions



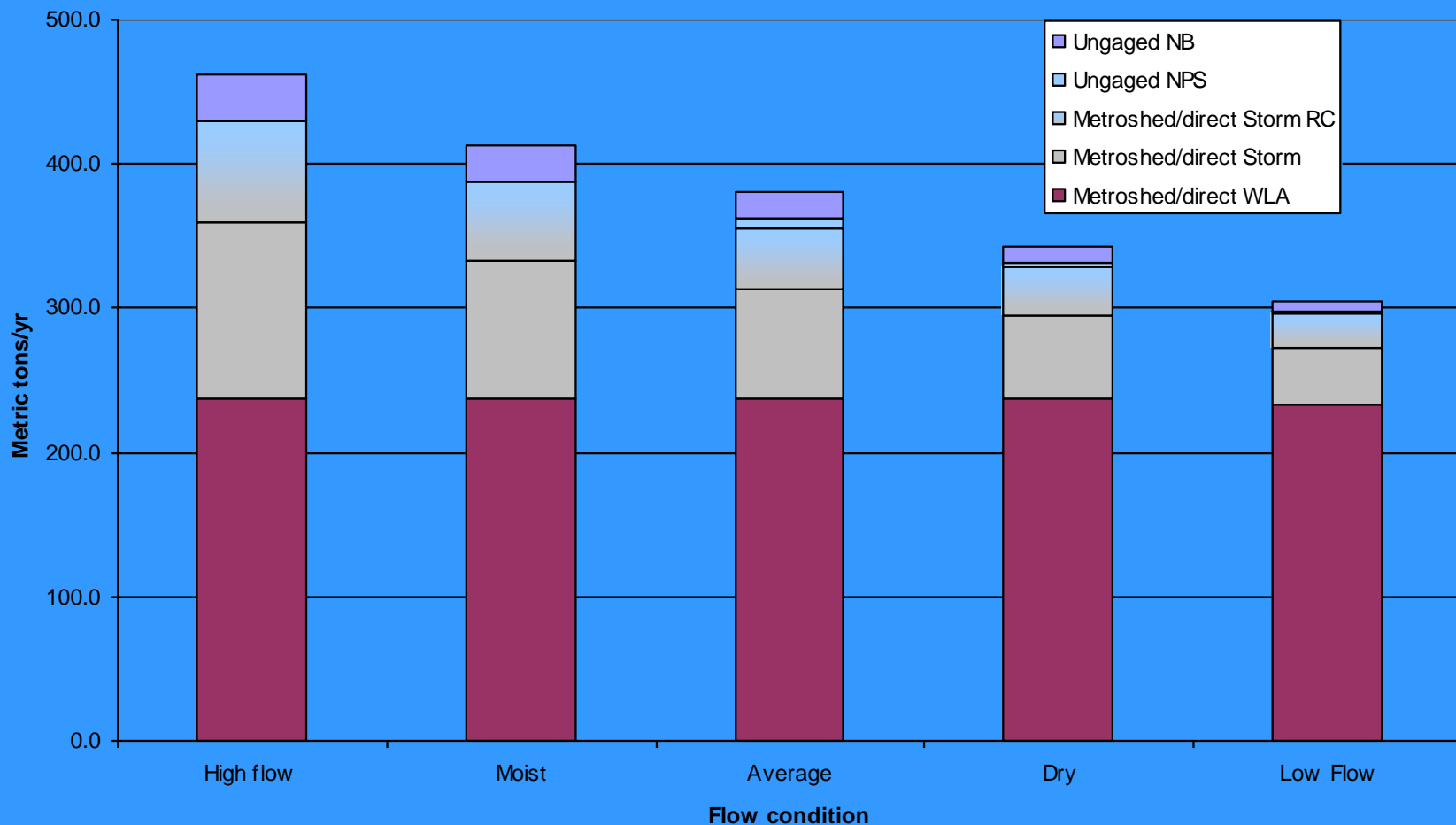
TP Load Allocations by Sector

Lake Pepin Basin



Draft Metroshed Allocations

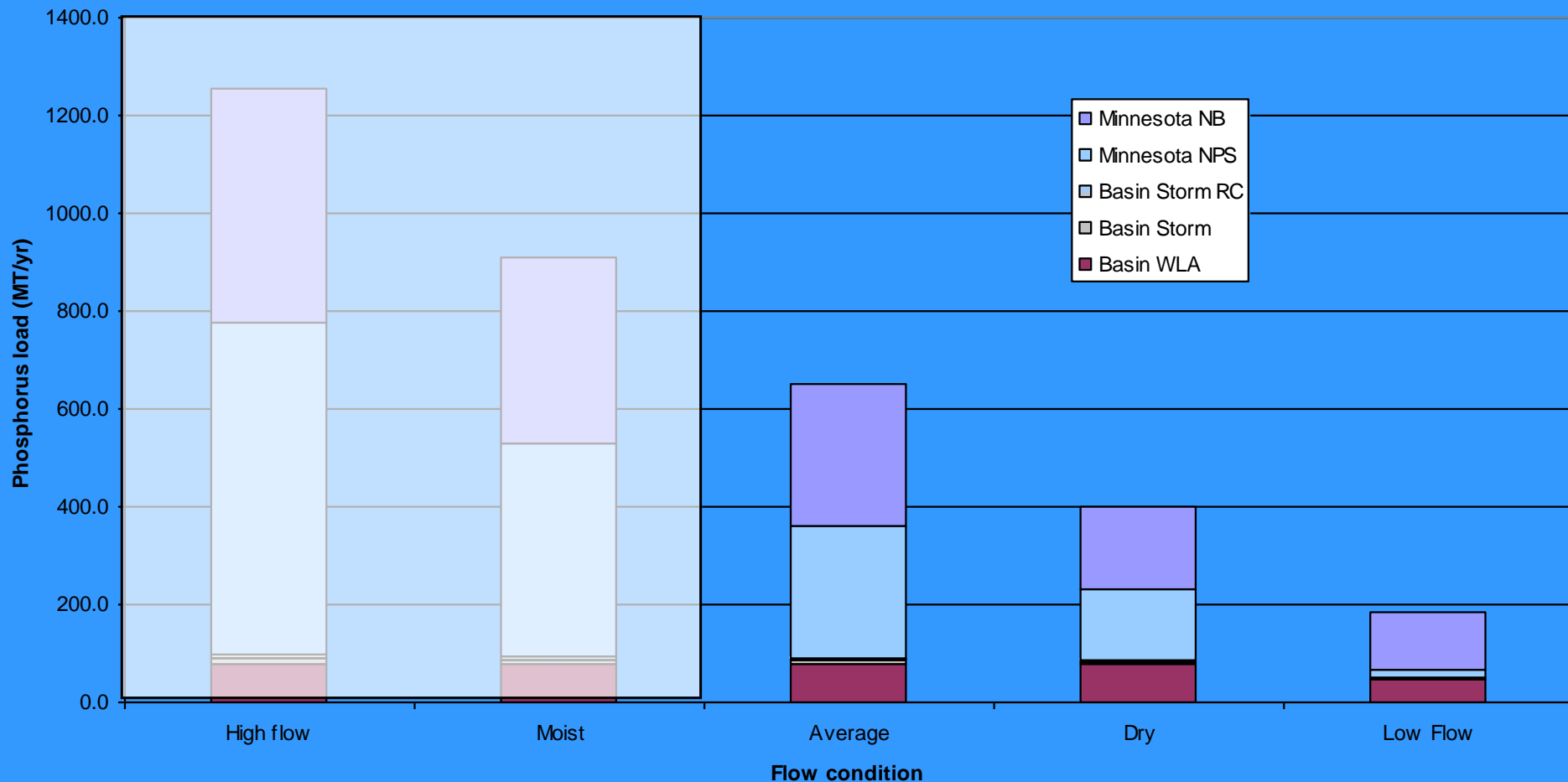
Metroshed phosphorus allocation for scenario 17



Note 6 MCES facilities = 180 MT/yr

Minnesota Basin

Total Phosphorus allocations for the Minnesota River Basin upstream of the metoshed to meet Lake Pepin TMDL goals.



Together
Minnesotans
Developing
Legacies

Rep. Dennis Ozment, 2004

